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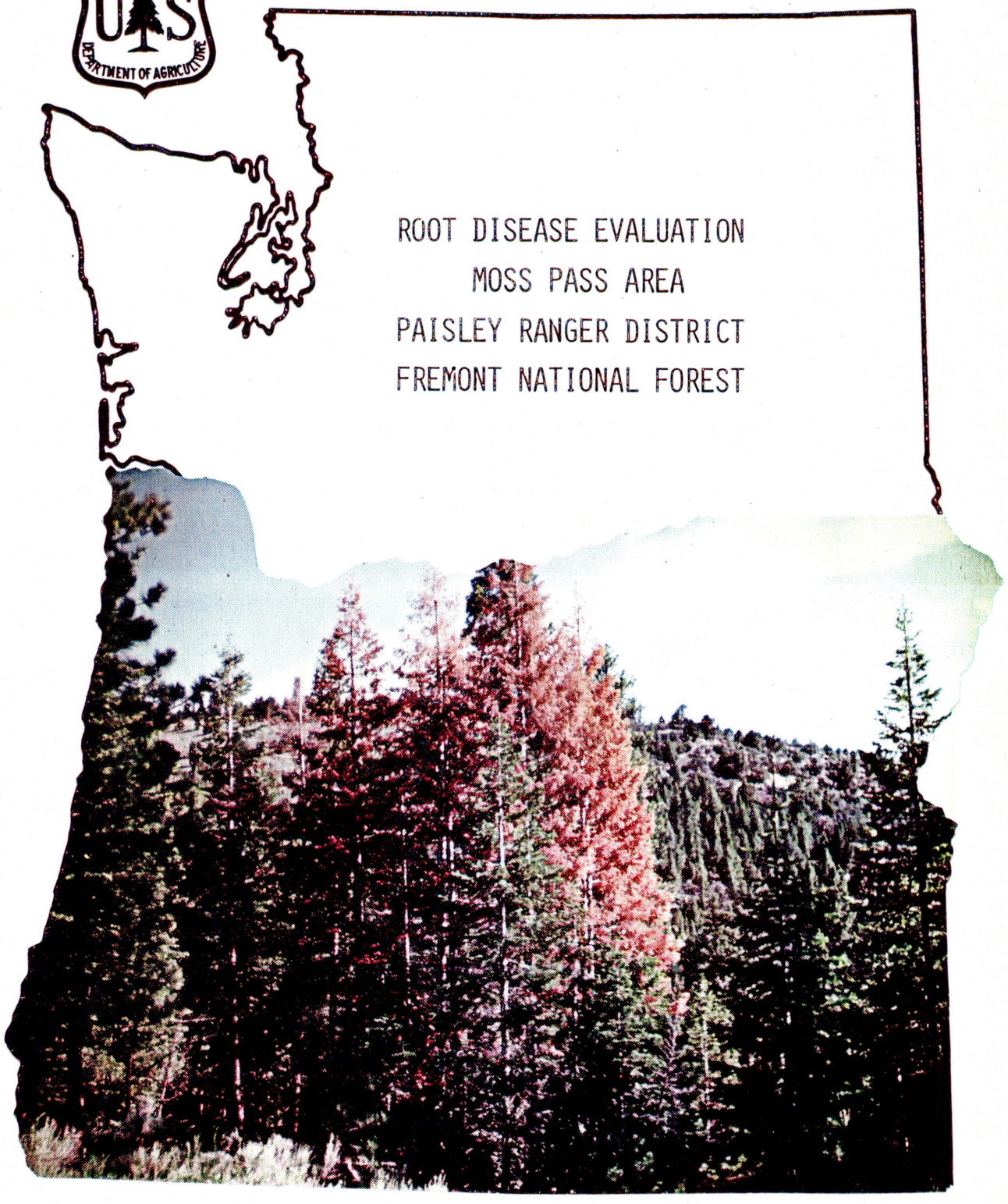
Forest Pest Management
Pacific Northwest Region



ROOT DISEASE EVALUATION
MOSS PASS AREA
PAISLEY RANGER DISTRICT
FREMONT NATIONAL FOREST

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by

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Introduction

During the week of June 21, 1982, a Forest Pest Management crew did a pest survey of two stands in the Moss Pass area, Paisley Ranger District, Fremont National Forest (Figure 1). District personnel had noticed a high incidence of white fir mortality in and around these stands and suspected that root disease was responsible. They requested a biological evaluation to determine distribution and intensity of damage and to provide pest management recommendations.

Methods

Systematic surveys of both stands were done by locating variable radius plots at 4-chain (264') intervals along transects spaced 4 chains apart across the stands. A Spiegel-Relaskop was used to define each plot, and basal area factors of 40 and 20 were used in Blocks A and B, respectively. Each plot was inspected for dead, dying, or symptomatic trees with root diseases or bark beetle infestation. Identity of pests causing mortality or decline was determined by removing bark from the stem and root collar to expose fungal mycelia and bark beetle galleries and by chopping into the heartwood of roots to determine presence of stain or decay. Samples of stained or decayed roots were returned to the laboratory and cultured on Basidiomycete-selective medium. Data recorded for all diseased and insect-infested trees were: species, diameter breast height (DBH), condition (dead or alive), and pathogen(s) and/or insect(s) present. Every fifth plot was a count plot in which all trees (including healthy) were tallied by species, DBH, and condition (live, dead, standing, down). From data collected in prism plots, mean basal area and number of trees per acre were calculated by species, DBH class, condition and, where appropriate, cause of death or decline.

In addition to taking plot data, surveyors reconnoitered the areas between plots and transects and noted locations of pockets of insect-infested and/or diseased trees. Thus, disease and insect centers could be mapped for the entire area of each stand.

Results and Discussion

Block A (T. 36 S., R. 19 E., sec. 9)

This survey unit is 58 acres in size and lies astride a small tributary of Green Creek. The current stand is composed of ponderosa pine (*Pinus ponderosa*) and white fir (*Abies concolor*), with some western juniper (*Juniperus occidentalis*) on the drier areas. The stand has been partially harvested several times in the past using selection and/or salvage methods. Both ponderosa pine and white fir were cut. The current stand can be classified as all-aged. Seedlings to overmature white fir are present, with poles and small sawtimber predominating. Ponderosa pine is represented mostly by mature to overmature sawtimber except for heavily-stocked patches of saplings in the south corner.

Mean basal areas and number of trees per acre are summarized in Tables 1 and 2. Dead trees accounted for 15.5 percent of the basal area and 23.1 percent of the stems. Root diseases (mainly annosus root rot caused by *Fomes annosus* but also Armillaria root rot caused by *Armillaria mellea*) were the primary contributing factors to white fir death. Fir engraver beetles (*Scolytus ventralis*) were found as secondary attackers of many root-diseased white firs. Mountain pine beetles (*Dendroctonus ponderosae*) and western pine beetles (*P. brevicomis*) were associated with most ponderosa pine mortality. Western dwarf mistletoe (*Arceuthobium campylopodum*) had infected and, undoubtedly, caused reduction in growth and vigor in some ponderosa pines. Infection levels and mortality rates caused by pests are summarized in terms of basal area and trees per acre in Tables 3 and 4. Distributions of forest pests in the unit are shown in Figure 2.

Block B (T. 36 S., R. 19 E., sec. 3 and 4; T. 35 S., R. 19 E., sec. 33 and 34)

This survey unit is 54 acres in size and is located on a northwest-facing slope above Moss Creek. Much of the original overstory in this stand was removed by selection or salvage logging in the past. Approximately 5 years ago, the residual understory was precommercially thinned. In the current stand, the few older trees remaining are mostly ponderosa pine, while the understory is composed of about equal numbers of sapling-to-pole-sized white fir and ponderosa pine.

Mean basal areas and number of trees per acre are presented in Tables 5 and 6. Dead trees accounted for 9.8 percent of the basal area and 7.3 percent of the stems. Root diseases of white fir did not appear to be nearly so damaging in this stand as they were in Block A. Although some annosus root rot occurred in the stand, distribution was very spotty, and no disease was encountered in prism plots. However, there was a very large and severe area of annosus root rot just outside of the boundary of this unit to the south. Other patterns of mortality and the pests causing growth loss and mortality were similar to those found in Block A. Basal area and trees per acre infected or killed by pests are presented in Tables 7 and 8, and distribution of pests are shown in Figure 3.

Diseases

Annosus Root Rot - The most serious disease problem in the Moss Pass area is annosus root rot, caused by the fungus, *F. annosus*. This pathogen is found in many parts of the world, causing root and butt rot or mortality in conifers. However, true firs (*Abies* spp.) are the only species seriously affected by this pathogen in most East Side mixed-conifer stands. The pathogen is spread by windborne spores. Fruiting bodies (conks), usually found in hollow stumps (Plate 1), produce large numbers of spores that can be wind-carried for long distances. Spores that land on freshly-cut stump surfaces or recently-created wounds can germinate and colonize woody tissues of the stump or tree. Subsequently, the fungus can grow throughout the root system and spread to nearby trees across root grafts or contacts. Infection leads to tree decline and death (Plates 2 and 5). Centers of mortality develop as trees progressively become infected and die. Radial spread of centers is approximately 1 foot per year.

Annosus root rot can be identified on dead or dying true fir by examining roots for the characteristic red-brown incipient decay (Plate 3) or white, stringy advanced decay with black flecks. Infection is confirmed by culturing stained or decayed wood on selective medium and observing formation of the microscopic asexual fruiting bodies. While the conks of *F. annosus* are usually not found on recently-killed fir, they are very common in the interior of older stumps (Plate 1). These stumps are usually associated with mortality of adjacent trees and can be considered the source of infection.

The high incidence of *F. annosus*-caused mortality observed in the Moss Pass area is undoubtedly due to the occurrence of the large numbers of infected white fir stumps resulting from past entries and the abundance of susceptible white fir, especially in the heavily stocked understory. The exclusion of fire from these stands in the past 60-80 years has favored the establishment of fir over ponderosa pine on sites that formerly were dominated by the latter species. We believe that amount and severity of annosus root rot in stands in the Moss Pass area will remain high unless managed by favoring tree species other than white fir on these sites.

Armillaria root rot - *Armillaria mellea*, cause of Armillaria root rot, survives as a saprophyte in old stumps and root systems and can infect nearby trees, across root contacts, or by growing short distances through the soil. In most cases, *A. mellea* acts as a weak pathogen that infects and helps kill stressed and unthrifty trees. Oftentimes another pest will be the primary cause of mortality.

Armillaria mellea can be identified on infected trees by exposing the inner bark of roots, or the root collar, and finding white-cream colored mycelial fans (Plate 4). Also characteristic and often found are rhizomorphs, black, string-like, infective structures that grow on the exterior of roots.

Where Armillaria root rot was found in the Moss Pass area, it was mostly on trees also infected by *F. annosus* or on small, suppressed trees in overstocked clumps.

Dwarf Mistletoes - These are parasitic higher plants that are serious pests of conifers in some areas. On the East Side, there are a number of species, all of which are rather host-specific and cause significant damage to only one or two host species.

Dwarf mistletoes harm their host by drawing on the tree's photosynthate and water reserves, thus lowering its vigor and ability to grow. Abnormal branch formations are common in response to infection. These include "witches-brooms" and abnormally large branches that lower a tree's grade and reduce its value. Following many years of infection, the parasite can build up on the host. Vigor may then be sufficiently reduced to cause outright mortality or predisposition to attack by other pests.

Dwarf mistletoes spread within and between hosts during the late summer and fall via forciby discharged seeds. Seeds shot out from female mistletoe plants on infected overstory trees fall down into lower branches and the crowns of trees in the understory, initiating new infections.

Ponderosa pine is lightly to moderately infected by dwarf mistletoe (*Arceuthobium campylopodum*) throughout the Moss Pass area. Dwarf mistletoes are best controlled by removing infected overstory trees before the understory is infected.

Insects

Mountain pine beetle - The mountain pine beetle (*Dendroctonus ponderosae*) is a common pest of lodgepole (*Pinus contorta*) and ponderosa pines in East Side mixed-conifer stands. This insect is identified by its long, vertical adult galleries with alternately branching larval galleries along the sides. In ponderosa pine, killing by mountain pine beetle mainly occurs in overstocked stands, usually involving scattered individuals or groups of trees in locations where basal area exceeds 150 ft^2.

Moderate levels of mountain pine beetle activity were observed throughout the Moss Pass area. This insect is best managed through stocking control.

Western pine beetle - The western pine beetle (*Dendroctonus brevicomis*) most commonly attacks overmature ponderosa pine. It is identified by its sinuous, multidirectional adult galleries. The western pine beetle is less aggressive than the mountain pine beetle, preferring trees of reduced vigor. Mortality attributed to this bark beetle often is the result of predisposition by other pests, such as dwarf mistletoe, root rots, or other insects.

Ponderosa pine mortality associated with the western pine beetle was observed at a fairly low level throughout the Moss Pass area. Mortality occurred in scattered single overstory trees. This bark beetle is best controlled by promoting and maintaining good stand vigor. Stocking control and shortened rotations greatly reduce the likelihood of stand damage by western pine beetle.

Fir engraver beetle - The fir engraver (*Scolytus ventralis*) is the most common bark beetle that attacks true firs. Trees of all sizes can be infested, but the insects are most successful on trees that have been weakened by another factor, such as root disease or drought (Plate 5). The fir engraver is identified by the short horizontal adult galleries and the many opposite, vertical galleries of the larvae.

Fir engravers were found infesting white firs throughout the Moss Pass area. Most, however, were trees also infected by *F. annosus*.

Management Recommendations

Levels of annosus root rot and associated fir engraver beetle activity detected in survey Block A and observed in many other stands in the Moss Pass area and north along the Winter Rim are some of the highest encountered in Oregon. This disease will require special consideration when determining how to manage stands that contain white fir anywhere in this vicinity. Dwarf mistletoe and bark beetles on ponderosa pine also pose a significant problem in portions of some stands. We recommend the following specific pest management strategies for the area:

(1) Wherever annosus root rot occurs on white fir and especially in areas where old white fir stumps with *F. annosus* conks are common, discriminate against white fir. Favor ponderosa pine, a tree species well adapted to the site and not damaged by the strain of *F. annosus* that infects white fir.

(2) Stands that contain white fir and do not yet exhibit annosus root rot should be monitored for root disease. If it is determined that selective cutting is to be done in the overstory, and that understory white fir is to be retained and managed, all white fir stumps should be treated by sprinkling their surfaces with borax within 48 hours of cutting. This will prevent infection by windborne spores. Injury of white fir leave trees should be strictly avoided. Although evidence of Indian paint fungus (*Echinodontium tinctorium*) was not found in surveyed stands, advanced white fir regeneration, if managed, should be unwounded, vigorously growing, and have good live crown ratios. Such trees will have a lower probability of infection by the Indian paint fungus and other heartrot fungi, including *F. annosus*.

(3) Damage due to ponderosa pine dwarf mistletoe can be eliminated or at least minimized by using one of the following silvicultural treatments in stands where it occurs: (a) clearcut the stands and artificially regenerate with pine. Be sure to establish a mistletoe-free boundary if this treatment is used; (b) using a seed tree or shelterwood system with adequate site preparation, leave an overstory of the healthiest seed-producing ponderosa pine. If seed trees have <u>any</u> mistletoe infections, they should be removed before the new regeneration is 3 feet tall or 10 years old, whichever occurs first; (c) in lightly infected stands with an adequately stocked understory, consider harvesting the overstory and retaining the residual. Thin the residual 3 years after harvest, favoring first, dominant and codominant trees with no visible mistletoe infections and second, dominant and codominant trees with no infections in the top half of the crown. Never retain trees with infected leaders or heavy infections in the top third of the crown. Progressively remove infected trees in subsequent entries. However, do not sacrifice adequate stocking for mistletoe control, especially if trees are only moderately infected.

(4) To minimize damage due to bark beetles in ponderosa pine: (a) control pine stocking in all stands. Thin pines to such a level that stocking will not exceed 150 ft^2 (preferably 120 ft^2) by the time of the following entry; (b) manage stands on a rotation of 120 years or less.

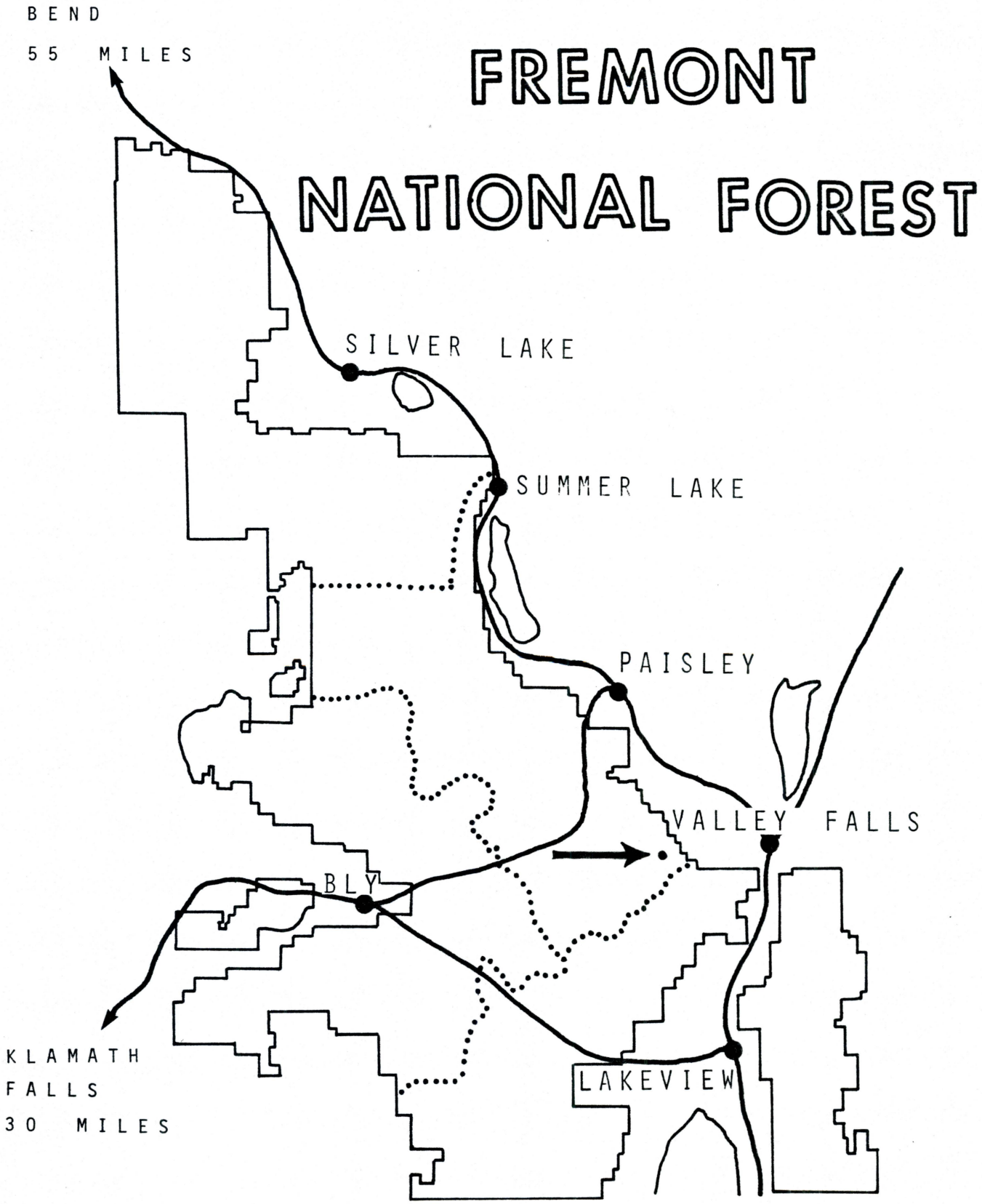


Figure 1. -- Map depicting location (arrow) of the survey areas, Paisley Ranger District, Fremont NF.

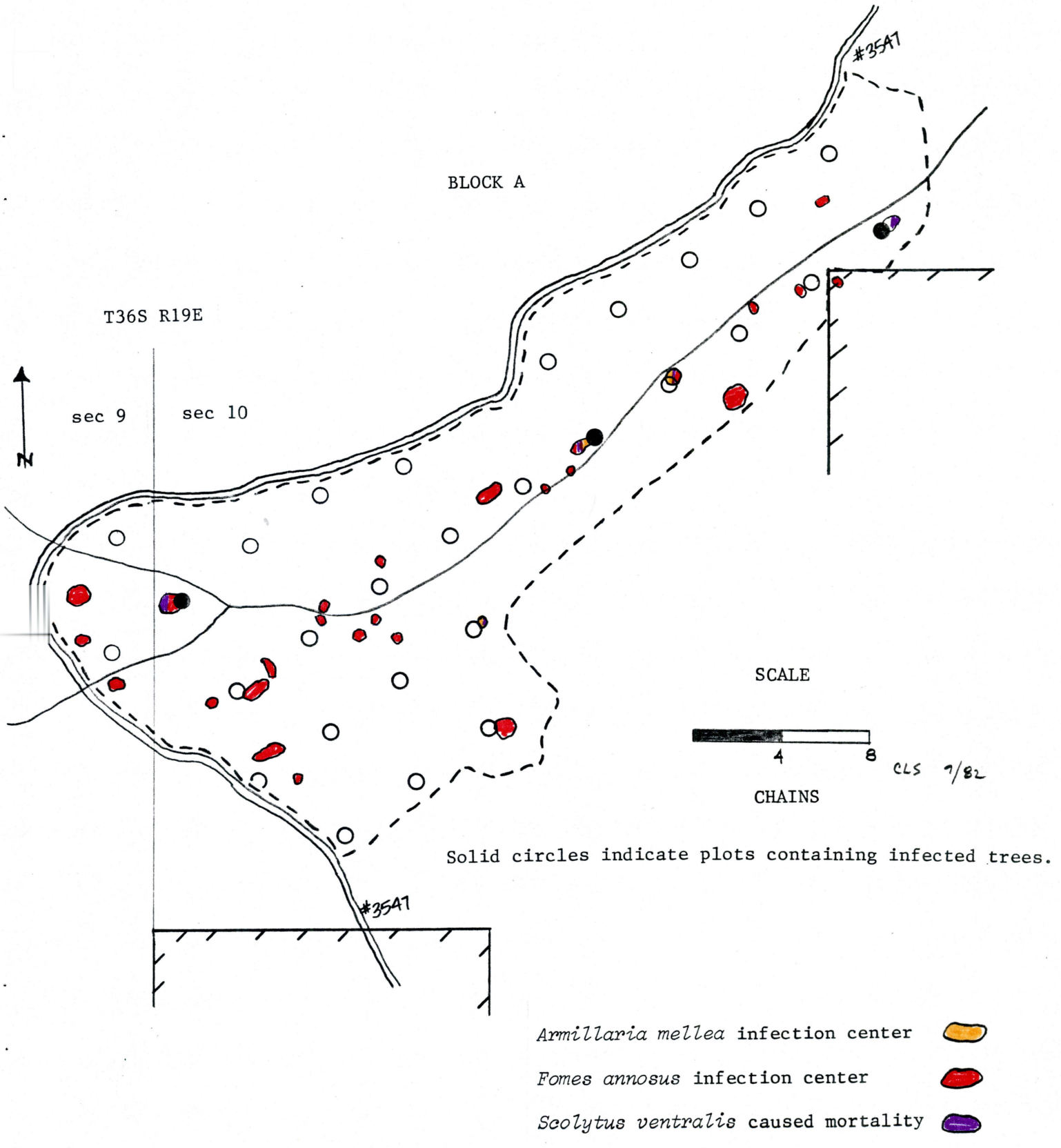
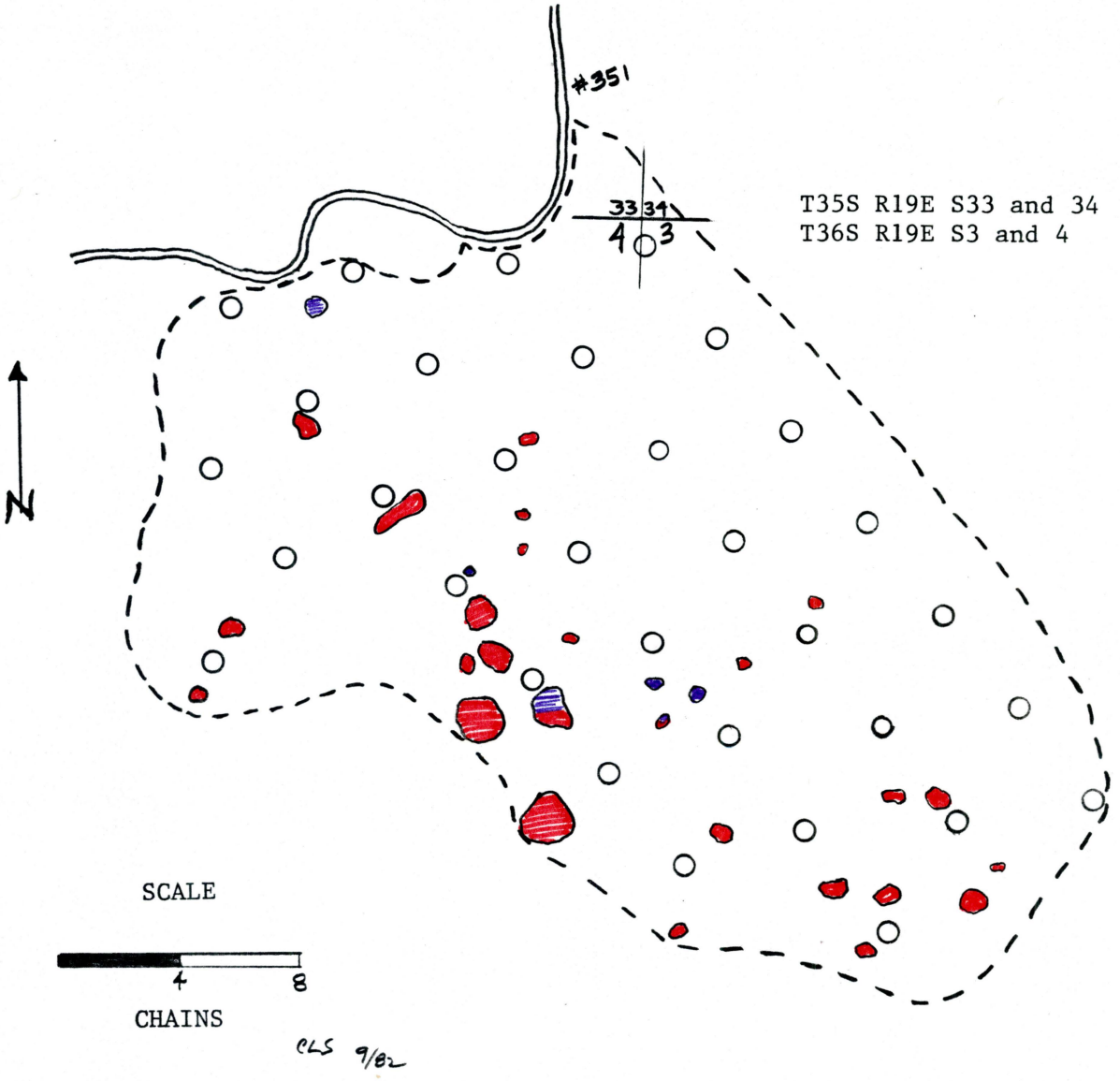


Figure 2. Distribution of major forest pests in Block A. Circles indicate location of cruise plots. Multiple color coded centers indicate more then one pest found. Bark beetle infestation and dwarf mistletoe infection of ponderosa pine occurred mainly on scattered individual trees throughout the stand and thus are not shown on the map.

PAISLEY RD

FREMONT NF

BLOCK B



Fomes annosus infection center

Scolytus ventralis caused mortality

Figure 3. Distribution of major forest pests in Block B. Circles indicate locations of cruise plots. Multiple color coded centers indicate more then one pest found. Bark beetle infestation and dwarf mistletoe infection of ponderosa pine occurred mainly on scattered individual trees throughout the stand and thus are not shown on the map.

Plate 1. *Fomes annosus* fruiting bodies (conks) inside an old white fir stump.

Plate 2. White fir mortality caused by *Fomes annosus*.

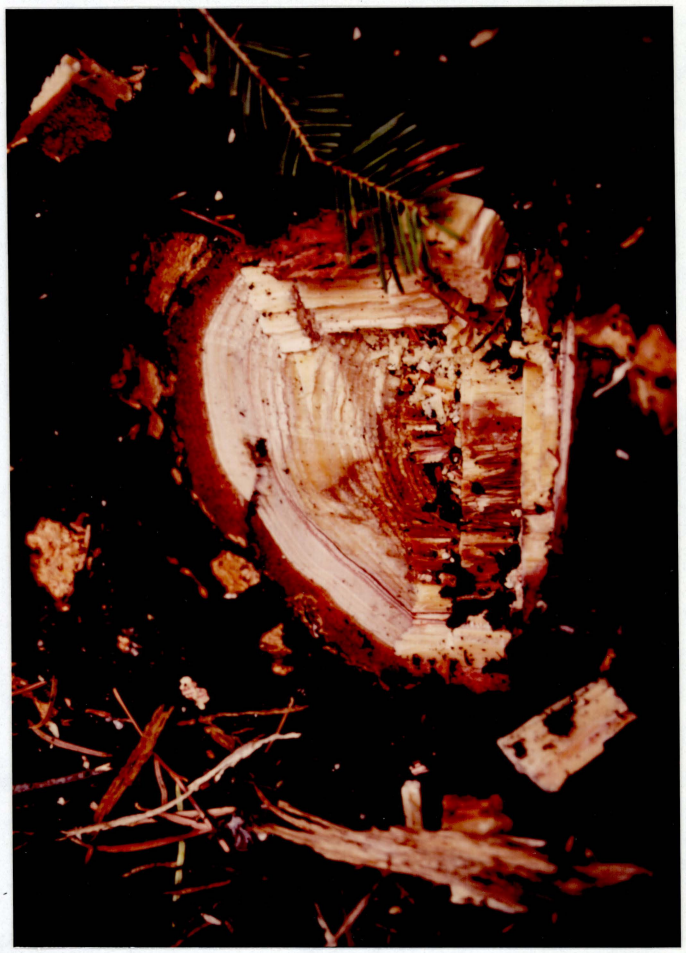


Plate 3. Red-brown incipient decay within a white fir root caused by *Fomes annosus*.

Plate 4. Mycelial fans on white fir characteristic of *Armillaria mellea*.

Plate 5. Mortality of white fir caused by a bark beetle (*Scolytus ventralis*)-root disease (*Fomes annosus*) complex.

Table 1.--Mean Basal Area Per Acre ($Ft.^2$) by Tree Species, Condition, and Diameter Class, Moss Pass Block A.

	WHITE FIR		PONDEROSA PINE		WESTERN JUNIPER		
DBH Class	Live	Dead	Live	Dead	Live	Dead	
4	0	0	8	3	0	0	
6	0	1.5	8	0	0	0	
8	0	0	0	0	0	0	
10	0	0	0	0	0	0	
12	0	0	0	0	0	0	
14	0	0	8	1.5	0	0	
16	0	0	0	1.5	8	0	
18	1.5	0	0	0	0	0	
20	0	0	0	0	0	0	
22	0	1.5	0	0	0	0	
24	0	0	8	1.5	0	0	
26	8	0	0	0	0	0	
28	0	1.5	0	0	0	0	
30	0	0	0	0	0	0	
32	0	1.5	16	0	0	0	
34	0	0	0	0	0	0	
36	0	0	0	0	0	0	
38	0	0	8	0	0	0	
Total	9.5	6.0	56	7.5	8	0	
Grand Total							87.0

Table 2.--Mean Number of Trees Per Acre by Species, Condition, and Diameter Class, Moss Pass Block A.

	WHITE FIR		PONDEROSA PINE		WESTERN JUNIPER		
DBH Class	Live	Dead	Live	Dead	Live	Dead	
4	0	0	92	34	0	0	
6	0	8	41	0	0	0	
8	0	0	0	0	0	0	
10	0	0	0	0	0	0	
12	0	0	0	0	0	0	
14	0	0	7	1	0	0	
16	0	0	0	1	6	0	
18	1	0	0	0	0	0	
20	0	0	0	0	0	0	
22	0	1	0	0	0	0	
24	0	0	3	<1	0	0	
26	2	0	0	0	0	0	
28	0	<1	0	0	0	0	
30	0	0	0	0	0	0	
32	0	<1	3	<1	0	0	
34	0	0	0	0	0	0	
36	0	0	0	0	0	0	
38	0	0	1	0	0	0	
40	0	0	0	0	0	0	
Totals	3	10	147	37	6	0	
Grand Total							203

Table 3.--Mean Basal Area Per Acre (Ft.^{2} by Disease or Insect, Condition, and Diameter Class, Moss Pass Block A.

DBH Class	LIVING TREES WITH Root Disease	LIVING TREES WITH Dwarf Mistletoe	DEAD TREES WITH Root Disease	DEAD TREES WITH Fir Engraver	DEAD TREES WITH Mountain Pine Beetle	DEAD TREES WITH Western Pine Beetle
4	0	0	0	0	3	0
6	0	0	1.5*	1.5*	0	0
8	0	0	0	0	0	0
10	0	0	0	0	0	0
12	0	0	0	0	0	0
14	0	0	0	0	0	1.5
16	0	0	0	0	1.5	0
18	1.5	0	0	0	0	0
20	0	0	0	0	0	0
22	0	0	1.5*	1.5*	0	0
24	0	8	0	0	0	1.5
26	0	0	0	0	0	0
28	0	0	1.5	0	0	0
30	0	0	0	0	0	0
32	0	8	1.5*	1.5*	0	1.5
34	0	0	0	0	0	0
36	0	0	0	0	0	0
38	0	0	0	0	0	1.5
Totals	1.5	16	6.0	4.5	4.5	6.0

Note: Trees infected with more than one pest are represented in each respective column, and are marked with an asterisk representing the same tree within identical DBH class.

Table 4.--Mean Number of Trees Per Acre by Disease or Insect, Condition, and Diameter Class, Moss Pass Block A.

DBH Class	LIVING TREES WITH Root Disease	LIVING TREES WITH Dwarf Mistletoe	DEAD TREES WITH Root Disease	DEAD TREES WITH Fir Engraver	DEAD TREES WITH Mountain Pine Beetle	DEAD TREES WITH Western Pine Beetle
4	0	0	0	0	34	0
6	0	0	8	8	0	0
8	0	0	0	0	0	0
10	0	0	0	0	0	0
12	0	0	0	0	0	0
14	0	0	0	0	0	1
16	0	0	0	0	1	0
18	1	0	0	0	0	0
20	0	0	0	0	0	0
22	0	0	1	1	0	0
24	0	3	0	0	0	<1
26	0	0	0	0	0	0
28	0	0	1	0	0	0
30	0	0	0	0	0	0
32	0	1	<1	<1	0	<1
34	0	0	0	0	0	0
36	0	0	0	0	0	0
38	0	0	0	0	0	<1
Totals	1	4	10	9	35	2

Note: Trees infected with more than one pest are represented in each respective column.

Table 5.--Mean Basal Area Per Acre ($Ft.^2$) by Tree Species, Condition, and Diameter Class, Moss Pass Block B.

DBH Class	White Fir		Ponderosa Pine		
	Live	Dead	Live	Dead	
4	10	0	0	0	
6	0	0	3	2	
8	7	1	7	0	
10	7	0	7	0	
12	0	0	0	0	
14	0	0	3	1	
16	4	0	4	0	
18	0	0	0	0	
20	0	0	0	0	
22	0	0	0	0	
24	0	0	0	1	
26	0	0	3	0	
28	0	0	0	0	
30	0	0	0	1	
Totals	28	1	27	5	
Grand Total					61

Table 6.--Mean Number of Trees Per Acre by Species, Condition, and Diameter Class, Moss Pass Block B.

DBH Class	White Fir		Ponderosa Pine		
	Live	Dead	Live	Dead	
4	115	0	0	0	
6	0	0	17	12	
8	19	2	19	0	
10	12	0	12	0	
12	0	0	0	0	
14	0	0	3	1	
16	2	0	2	0	
18	0	0	0	0	
20	0	0	0	0	
22	0	0	0	0	
24	0	0	0	<1	
26	0	0	1	0	
28	0	0	0	0	
30	0	0	0	<1	
Totals	148	2	54	14	
Grand Total					218

Table 7.--Mean Basal Area Per Acre ($Ft.^2$) by Disease or Insect, Condition, and Diameter Class, Moss Pass Block B

	LIVING TREES WITH	DEAD TREES WITH		
DBH Class	Dwarf Mistletoe	Fir Engraver	Mountain Pine Beetle	Western Pine Beetle
4	0	0	0	0
6	0	0	2	0
8	3	1	0	0
10	0	0	0	0
12	0	0	0	0
14	0	0	1*	1*
16	3	0	0	0
18	0	0	0	0
20	0	0	0	0
22	0	0	0	0
24	0	0	1	0
26	0	0	0	0
28	0	0	0	0
30	0	0	1	0
32	0	0	0	0
34	0	0	0	0
36	0	0	0	0
38	0	0	0	0
Totals	6	1	5	1

*Represented by the same tree.

Table 8.--Mean Number of Trees Per Acre by Disease or Insect, Condition, and Diameter Class, Moss Pass Block B

	LIVING TREES WITH	DEAD TREES WITH		
DBH Class	Dwarf Mistletoe	Fir Engraver	Mountain Pine Beetle	Western Pine Beetle
4	0	0	0	0
6	0	0	12	0
8	10	2	0	0
10	0	0	0	0
12	0	0	0	0
14	0	0	1*	1*
16	2	0	0	0
18	0	0	0	0
20	0	0	0	0
22	0	0	0	0
24	0	0	<1	0
26	0	0	0	0
28	0	0	0	0
30	0	0	<1	0
Totals	12	2	14	1

*Represented by the same tree.

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